

IN THE CLAIMS:

- 1 1. (Original) A system for synchronizing dependencies upon a set of persistent
2 consistency point images (PCPIs) among a set of computers, the system comprising:
3 means for identifying a dependency upon the set of PCPIs;
4 means for creating a set of soft locks, each soft lock in the set of soft locks associ-
5 ated with each of the PCPIs in the set of PCPIs; and
6 means for transmitting the set of soft locks to one or more of the set of computers.
- 1 2. (Original) The system of claim 1 wherein the set of computers comprises a
2 set of storage appliances.
- 1 3. (Original) The system of claim 1 wherein each soft lock comprises a PCPI
2 identifier field, a type field and a string field.
- 1 4. (Original) The system of claim 3 wherein the string field comprises user visi-
2 ble information.
- 1 5. (Original) The system of claim 3 wherein the string field identifies an appli-
2 cation that depends upon the PCPI associated with the soft lock.
- 1 6. (Original) The system of claim 3 wherein the type field identifies a type of
2 data in the string field.
- 1 7. (Original) The system of claim 6 wherein the type of data comprises an
2 owner name.
- 1 8. (Original) The system of claim 6 wherein the type of data comprises a desti-
2 nation path.

1 9. (Original) The system of claim 6 wherein the type of data comprises a qtree
2 name.

1 10. (Original) The system of claim 1 wherein the means for transmitting the set
2 of soft locks to one or more of the set of computers further comprises:
3 means for transmitting the set of soft locks before an asynchronous mirroring
4 process; and
5 means for transmitting the set of soft locks after an asynchronous mirroring proc-
6 ess.

1 11. (Currently Amended) A method for synchronizing dependencies upon a set of
2 persistent consistency point images (PCPIs) among a set of computers, ~~the method com-~~
3 ~~prising the steps of:~~
4 identifying a dependency upon the set of PCPIs;
5 creating a set of soft locks, each soft lock in the set of soft locks associated with
6 each of the PCPIs in the set of PCPIs; and
7 transmitting the set of soft locks to one or more of the set of computers.

1 12. (Currently Amended) The method of claim ~~4-11~~ wherein the set of computers
2 comprises a set of storage appliances.

1 13. (Currently Amended) The method of claim ~~4-11~~ wherein each soft lock comprises
2 a PCPI identifier field, a type field and a string field.

1 14. (Original) The method of claim 13 wherein the string field comprises user
2 visible information.

1 15. (Original) The method of claim 13 wherein the string field identifies an ap-
2 plication that depends upon the PCPI associated with the soft lock.

1 16. (Original) The method of claim 13 wherein the type field identifies a type of
2 data in the string field.

1 17. (Original) The method of claim 16 wherein the type of data comprises an
2 owner name.

1 18. (Original) The method of claim 16 wherein the type of data comprises a des-
2 tination path.

1 19. (Original) The method of claim 16 wherein the type of data comprises a qtree
2 name.

1 20. (Currently Amended) The method of claim ~~4~~11 wherein the step of transmitting
2 the set of soft locks to one or more of the set of computers further comprises ~~the steps of:~~
3 transmitting the set of soft locks before an asynchronous mirroring process; and
4 transmitting the set of soft locks after an asynchronous mirroring process.

1 21. (Original) A storage system for use in a storage system environment for
2 communicating dependencies upon a set of persistent consistency point images (PCPIs)
3 among a set of storage systems, the storage system comprising:
4 a storage operating system having a file system that implements PCPIs;
5 an application executing on the storage system, the application adapted to imple-
6 ment a soft lock to communicate a dependency with a specific PCPI; and
7 a network protocol module of the storage operating system, the network protocol
8 module operatively interconnected with the application and adapted to transfer the soft
9 lock to one or more storage systems in the set of storage systems.

1 22. (Original) The storage system of claim 21 wherein the application comprises
2 an asynchronous mirroring application.

- 1 23. (Original) The storage system of claim 21 wherein the soft lock comprises a
2 PCPI identifier field, a type field, and a string field.
- 1 24. (Original) The storage system of claim 23 wherein the string field comprises
2 user visible information.
- 1 25. (Original) The method of claim 23 wherein the string field identifies an ap-
2 plication that depends upon the PCPI associated with the soft lock.
- 1 26. (Original) The method of claim 23 wherein the type field identifies a type of
2 data in the string field.
- 1 27. (Original) The method of claim 26 wherein the type of data comprises an
2 owner name.
- 1 28. (Original) The method of claim 26 wherein the type of data comprises a des-
2 tination path.
- 1 29. (Original) The method of claim 26 wherein the type of data comprises a qtree
2 name.
- 1 30. (Currently Amended) A method for propagating soft locks through a cascaded
2 chain of storage systems comprising at least a downstream storage system and an up-
3 stream storage system, ~~the method comprising the steps of:~~
4 identifying a set of persistent consistency point images on the upstream storage
5 system that require a soft lock to be set;
6 creating soft locks for the identified set of persistent consistency point images;
7 sending the created soft locks to the upstream storage system; and

8 performing an asynchronous mirroring process to mirror local data to the down-
9 stream storage system.

1 | 31. (Currently Amended) The method of claim 30 further comprising ~~the steps of:~~
2 determining if a new persistent consistency point image exist on the downstream
3 storage system;
4 identifying, in response to a new persistent consistency image existing on the
5 storage system, a set of additional soft locks on the downstream storage system; and
6 sending the additional set of soft locks to the upstream storage system.

1 32. (Original) The method of claim 30 wherein the soft lock comprises a data
2 structure having an entry identifying a resource identifier and an identifier of a locking
3 data set.

1 33. (Original) The method of claim 32 wherein a resource identifier identifies a
2 persistent consistency point image ~~that the soft lock protects.~~

1 34. (Original) The method of claim 32 wherein the identifier of a locking dataset
2 identifies a resource on a downstream system that requires the use of the persistent con-
3 sistency point image identified in the resource identifier.

1 35. (Currently Amended) The method of claim 30 wherein the step of identifying a
2 set of persistent consistency point images on the upstream storage system that requires a
3 soft lock to be set further comprises ~~the steps of:~~
4 identifying a set of persistent consistency point images that are in common be-
5 tween the upstream storage system and the downstream storage system; and
6 identifying a set of persistent consistency point images that have a soft lock set
7 from one or more storage systems located downstream from the downstream storage sys-
8 tem.

1 36. (Original) The method of claim 30 wherein the downstream storage system
2 comprises a storage system to which mirrored data is transferred.

1 37. (Original) The method of claim 30 wherein the upstream storage system
2 comprises a storage system from which mirrored data is transferred.

1 38. (Original) A cascaded set of storage systems interconnected via one or more
2 networks, each of the storage systems comprising:
3 a storage operating system executing, the storage operating system including a
4 mirroring application adapted to create and maintain soft locks on the storage systems of
5 the cascaded set of storage systems.

1 39. (Original) The cascaded set of storage systems of claim 38 wherein the mir-
2 roring application implements a volume-based asynchronous mirroring process.

1 40. (Original) The cascaded set of storage systems of claim 38 wherein the mir-
2 roring application implements a qtree-based asynchronous mirroring process.

1 41. (Original) The cascaded set of storage systems of claim 38 wherein each of
2 the soft locks comprises a data structure having an entry defining a resource identifier and
3 an entry identifying a locking dataset.

1 42. (Original) The cascaded set of storage systems of claim 38 wherein the mir-
2 roring application is further adapted to propagate the soft locks to one or more of the
3 storage systems in the cascaded set of storage systems.

1 43. (Original) A storage system for use in a cascaded set of storage systems hav-
2 ing at least an upstream storage system, the storage system comprising:
3 means for identifying a set of persistent consistency point images on the upstream
4 storage system that require a soft lock to be set;

5 means for creating soft locks for the identified set of persistent consistency point
6 images; and

7 means for sending the created soft locks to the upstream storage system.

1 44. (Original) The storage system of claim 43 further comprising means for per-
2 forming an asynchronous mirroring process to mirror local data to a downstream storage
3 system.

1 45. (Original) The storage system of claim 44 wherein the storage system is
2 operatively interconnected with the downstream storage system via a network.

1 46. (Original) The storage system of claim 44 wherein the storage system is con-
2 nected to the upstream storage system and the downstream storage system via a network.

1 47. (Original) The storage system of claim 43 further comprising means for per-
2 forming an asynchronous mirroring process to mirror local data to the downstream stor-
3 age system.

1 48. (Original) A computer readable medium, including program instructions exe-
2 cuting on a storage system in a cascaded set of storage systems having at least an up-
3 stream storage system and a downstream storage system, the computer readable medium
4 including instructions for performing the steps of:

5 identifying a set of persistent consistency point images that are in common be-
6 tween the upstream storage system and the downstream storage system; and

7 identifying a set of persistent consistency point images that have a soft lock set
8 from one or more storage systems located downstream from the downstream storage sys-
9 tem;

10 creating soft locks for the identified set of persistent consistency point images;

11 sending the created soft locks to the upstream storage system; and

12 performing an asynchronous mirroring process to mirror local data to the down-
13 stream storage system.

1 49. (Original) The computer readable medium of claim 19 wherein local data
2 comprises data stored on storage devices associated with a storage system executing the
3 computer readable medium.

1 50. (Currently Amended) A method for synchronizing persistent consistency point
2 images among a plurality of computers, ~~the method comprising the steps of:~~
3 identifying a set of persistent consistency point images on a first computer of the
4 plurality of computers;
5 creating soft locks for the identified set of persistent consistency point images; and
6 sending the created soft locks to the plurality of computers.

1 51. (Previously Presented) The method of claim 50 wherein , in the identifying
2 step, the set of persistent consistency point images is identified, in the identifying step, on
3 an upstream storage system of the plurality of computers.

1 52. (Previously Presented) The method of claim 50 wherein, in the sending
2 step, the created soft locks are sent, to an upstream storage system of the plurality of
3 computers.

1 53. (Previously Presented) The method of claim 50 wherein, in the identifying
2 step, persistent consistency point images that require a soft lock to be set are identified.

1 54. (Previously Presented) The method of claim 50 further comprising:

2 performing an asynchronous mirroring process to mirror local data to a selected
3 computer of the plurality of computers, the soft locks maintaining consistency of the data
4 on the plurality of computers.

1 55. (Previously Presented) The method of claim 54 wherein, in the mirroring
2 step, the local data is mirrored to a down stream storage system of the plurality of com-
3 puters.

1 56. (Previously Presented) A method of synchronizing dependencies upon a set
2 of persistent consistency point images, comprising:
3 identifying a set of persistent consistency point images that are in common be-
4 tween an upstream storage system and a downstream storage system; and
5 identifying a set of persistent consistency point images that have a soft lock set
6 from one or more storage systems located downstream from the downstream storage sys-
7 tem;
8 creating soft locks for the identified set of persistent consistency point images;
9 and
10 sending the created soft locks to the upstream storage system.

1 57. (Previously Presented) The method of claim 56 further comprising:
2 performing an asynchronous mirroring process to mirror local data to the down-
3 stream storage system.

1 58. (Previously Presented) A system for synchronizing dependencies upon a set of
2 persistent consistency point images, comprising:
3 means for identifying a set of persistent consistency point images that are in
4 common between an upstream storage system and a downstream storage system; and

5 means for identifying a set of persistent consistency point images that have a soft
6 lock set from one or more storage systems located downstream from the downstream
7 storage system;

8 means for creating soft locks for the identified set of persistent consistency point
9 images; and

10 means for sending the created soft locks to the upstream storage system.

1 59. (Previously Presented) The system according to claim 58 further compris-
2 ing:

3 means for performing an asynchronous mirroring process to mirror local
4 data to the downstream storage system.

1 60. (Previously Presented) A computer data storage system cluster compris-
2 ing:

3 a primary storage system including an active file system;

4 a persistent consistency point image (PCPI) consisting of a point-in-time
5 image of the active file system;

6 at least one mirror image of the PCPI, the mirror image being stored on a
7 downstream storage system; and

8 at least one soft lock issued by the downstream storage system in response
9 to an application being dependent upon the PCPI, the soft lock consisting of a data
10 structure configured to prevent changes to the PCPI.

1 61. (Previously Presented) The computer data storage system cluster of claim
2 60 comprising:

3 a cascade of mirrored images of the PCPI stored on a plurality of data
4 storage systems in the cluster; and

5 wherein the at least one soft lock comprises a set of soft locks that are
6 communicated from downstream storage systems in the cluster to upstream stor-
7 age systems in the cluster.

1 62. (Previously Presented) The computer data storage system cluster of claim
2 60 comprising:

3 wherein the soft lock is transmitted from the downstream storage system
4 to the primary storage system over a data link.

1 63. (Previously Presented) The computer data storage system cluster of claim
2 60 comprising:

3 a field in the soft lock storing data identifying an owner of the soft lock
4 wherein the owner comprises the application being dependent upon the PCPI.

1 64. (Previously Presented) A method of managing data on a cluster of com-
2 puter data storage systems, the method comprising:

3 writing a persistent consistency point image (PCPI) on a primary storage
4 system, the PCPI consisting of a point-in-time image of an active file system op-
5 erating on the primary storage system;

6 writing at least one mirror image of the PCPI on a downstream storage
7 system; and

8 issuing at least one soft lock by the downstream storage system in re-
9 sponse to an application being dependent upon the PCPI, the soft lock consisting
10 of a data structure configured to prevent changes to the PCPI.

1 65. (Previously Presented) The method of claim 64 comprising:

2 writing a cascade of mirrored images of the PCPI on a plurality of data
3 storage systems in the cluster; and

4 wherein the at least one soft lock comprises a set of soft locks that are
5 communicated from downstream storage systems in the cluster to upstream stor-
6 age systems in the cluster,

1 66. (Previously Presented) The method of claim 64 comprising:

2 transmitting the soft lock from the downstream storage system to the pri-
3 mary storage system over a data link.

1 67. (Previously Presented) The method of claim 64 comprising:

2 storing data in the soft lock, the data identifying an owner of the soft lock
3 wherein the owner comprises the application being dependent upon the PCPI.

1 68. (Previously Presented) A computer readable medium, including program
2 instructions executing on a storage system in a cascaded set of storage systems
3 having at least an upstream storage system and a downstream storage system, the
4 computer readable medium including instructions for performing the steps of:

5 writing a persistent consistency point image (PCPI) on a primary storage
6 system, the PCPI consisting of a point-in-time image of an active file system op-
7 erating on the primary storage system;

8 writing at least one mirror image of the PCPI on a downstream storage
9 system; and

10 issuing at least one soft lock by the downstream storage system in re-
11 sponse to an application being dependent upon the PCPI, the soft lock consisting
12 of a data structure configured to prevent changes to the PCPI.

1 69. (Previously Presented) A computer data storage system cluster compris-
2 ing:

3 means for writing a persistent consistency point image (PCPI) on a pri-
4 mary storage system, the PCPI consisting of a point-in-time image of an active
5 file system operating on the primary storage system;

6 means for writing at least one mirror image of the PCPI on a down-
7 stream storage system; and

8 means for issuing at least one soft lock by the downstream storage sys-
9 tem in response to an application being dependent upon the PCPI, the soft lock
10 consisting of a data structure configured to prevent changes to the PCPI.